Effect of adding manganese on the structural and optical properties of zinc telluride thin film prepared by pulsed laser method.

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Abstract: -
In this paper, ZnTe and ZnTe: mn films were obtained by laser deposition using ZnTe and mn co-deposition method. 2Te was used as targets and the ratio of shots was varied to obtain pure ZnTe films and films with 2% mn. ZnTe films were deposited with mn manganese for the purpose of p-type carrier concentration and to prove the effect of manganese concentration on the structural and optical properties of ZnTe thin films to consider their potential applications in electronic devices. After structural investigations conducted by X-ray diffraction technique, the studied samples are polycrystalline and have a cubic shape with preferred orientation along (111). XRD patterns were used to determine the microscopic parameters (crystal size, lattice modulus). Atomic force microscopy (AFM) was used to study the surface roughness of the thin films.
A UV-Vis spectrophotometer was used to determine the energy gap.

Keyword:films ,pure,PLD .

1- Introduction:

ZnTe is a low cost semiconductor material of the Π-VI family. This crystal is usually cubic type zinc with a lattice constant of 6.2230 Å=A with a direct wide energy gap transition of 2.26 ev. High absorption, temperature 286 °C, melting point 1295 °C and p-type appears in nature [1]. Recently, ZnTe thin films have been greatly benefited, due to their potential applications to multi-junction tandem solar cells, LEDs, and cells Solar photodetectors, transistors, nanowires [5 3 2] Several methods have been developed to prepare zinc films such as (LPE), molecular beam amplification (MBE), thermal vapor deposition and pulsed laser doping (LPD) [4]. The ZnTe film with Cu has been studied by PLD laser deposition [5], the microstructure and magnetic study of ZnTe nanoparticles doped with manganese mn [6]. 7]. PLD technology allows to precisely control the thickness of the film of the film, down to the atomic level, to form manganese-doped films by sequential deposition of two materials in this case, it was used as targets ZnTe and ZnTe: mn. Thus, by changing the layer thickness of each of them, it is possible to control the amount of impurities in the films [8]. In this research, zinc telluride films were grafted with manganese using PLD technique and optical and structural characterization of the pure and doped films were performed.

2-Demo details

The doped ZnTe: mn and pure ZnTe thin films were deposited by PLD technique using 150 laser pulses. A material with 99.99% purity of ZnTe and mn supplied by KTAN FUNUCTION MATERIAL was used as targets. 3gm of powder was used to make the denatured samples and the impregnation percentages were (4% and 6%). Glass substrates were used as substrates. Prior to the sedimentation process, the glass slides were cleaned with acetone and deionized water and dried with a nitrogen gun. The settling chamber is emptied to a basic pressure of -1x10 3 Torr Before each film deposition, a laser with wavelength λ=1064 nm, laser pulse duration 10n sec, frequency 6 Hz, and energy 800mj was used. UV-Vis transmittance was evaluated using an Ocean Optics Spectra Suite spectrophotometer. The obtained measurements of transmittance were used to calculate the energy gap for each sample. The crystal structure of the samples was determined using a Rigku Ultima III X-ray diffractometer with Cu Ka radiation (λ=0.15406 nm). XRD assays were performed in the range of 10–80 of 2θ and the constant W°=1 was used to avoid substrate effects.

3- Results and discussion

3-1: - Structural properties

Figure (1) shows the XRD patterns of the ZnTe: mn films doped with a concentration (4% and 6%) of manganese. The XRD patterns in Figure (1) are consistent with the precipitated samples. In Figure (1) the peaks observed in the XRD of the deposited samples indicate that the films are It is a polycrystalline sediment belonging to the polycrystalline zinc alloy phase ZnTe (c=b=a 6.103 Å=28.499 θ 2° θ) with a strong trend in the (111) plane, placed at 28.4° from 2 θ. (1), some peaks appear at 41.567°, 52.373°, 54.068°, 59.26° from 2θ, indicating an excess of Te. All these results are in agreement with the introduction [9]. The intensity of the peaks increases with the increase in the thickness of the film indicating simultaneous growth. This shows that if the thickness is large, the atoms have enough time to precipitate on the substrate and the peak is at the preferred level (111) which has the highest density. . This leads to the improvement of the crystal structure of the ZnTe samples. Effect of manganese concentration on the crystal size in ZnTe films.

$$t = \frac{0.94\lambda}{B\cos\theta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Where: t is the diameter of the crystal, λ is the wavelength of the X-ray used

Multi-mode atomic force microscopy (AFM) was performed. The measurements were made to study the surface, crystal formation and growth pattern as well as measuring the grain sizes and surface roughness of the ZnTe: mn layers. AFM images show the surface morphology of ZnTe: mn layers at 1500 mv for 30 min on glass substrates shown in Fig. (2a and 2b). 3D AFM images reveal the growth pattern, both showed that ZnTe layers have vertical growth of different sizes, the changing sizes of vertically shaped thin-film materials leave undesirable gaps between vertical materials.

The researchers stated that these unwanted gaps cause the devices to shorten, which leads to poor performance when used in the manufacture of solar cells according to Fozy et al [7].

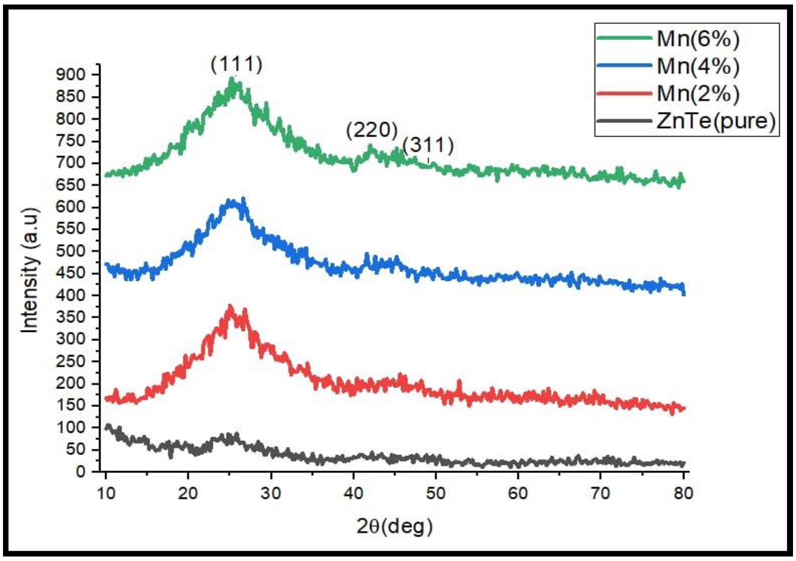


Figure 1 shows the XRD diagram of . films ZnTe: mn.

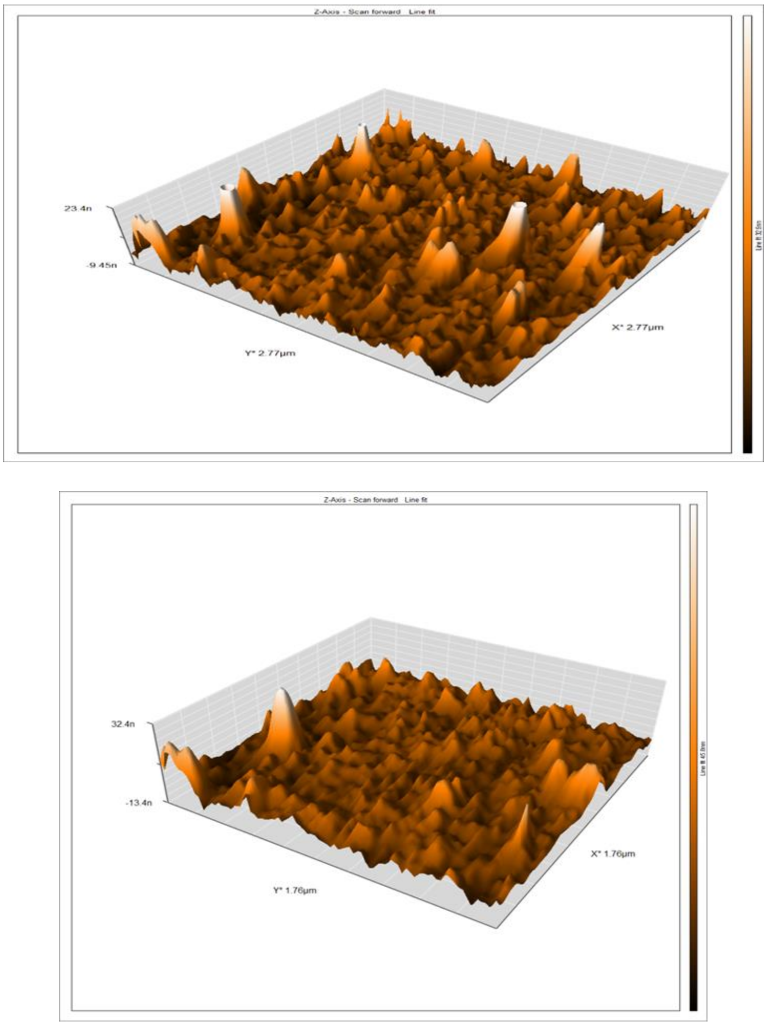
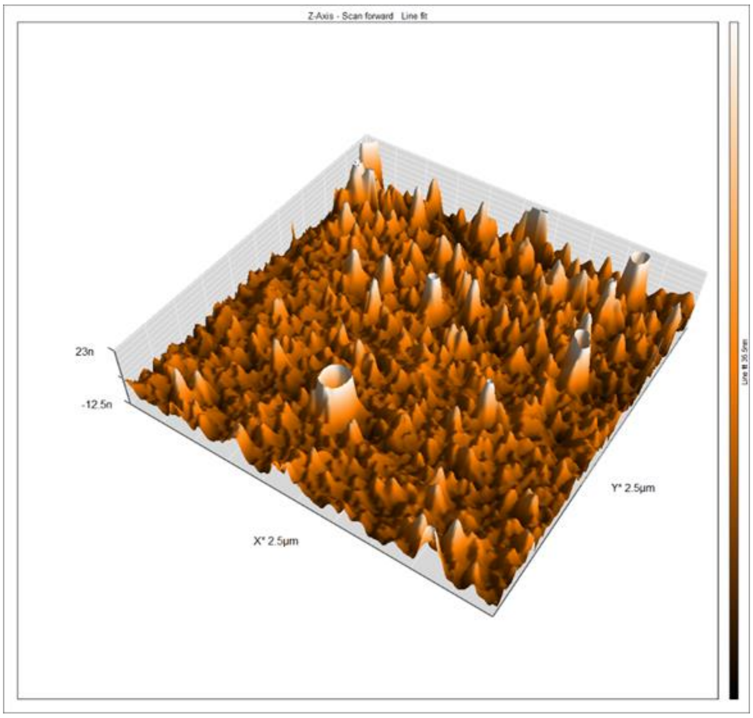


Figure (2a) 3D AFM images of a 4%-doped ZnTe: mn membrane.



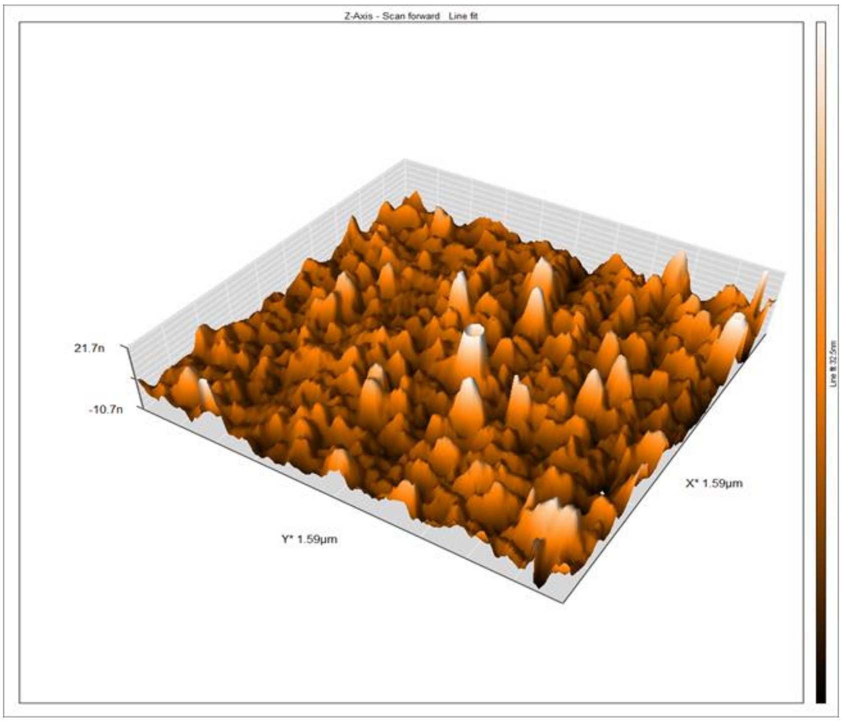


Figure (2a) 3D AFM images of a 4%-doped ZnTe: mn membrane.

3-2: - Optical properties

The optical behavior of doped ZnTe: mn samples was determined by doping ratios (4 and 6% (by Uv-Vis spectroscopy. Fig. 3)) transmittance spectra were determined in the wavelength range of 1100–300 nm. Different permeability behavior is observed between the films as the precipitated films show permeability values in the range of 90-60%. It was observed that the permeability of the thin films showed a gradual decrease of the permeability spectrum upon doping by (4 and 6%).

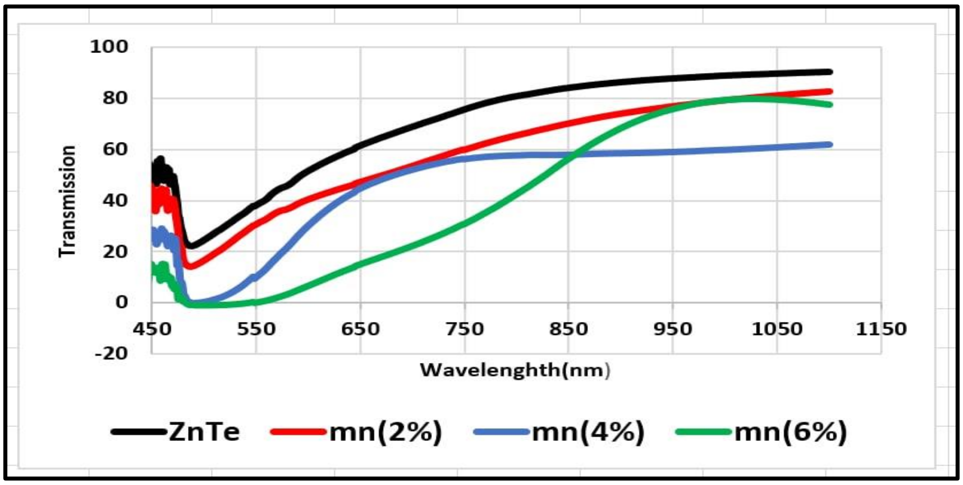


Figure 3 shows the permeability diagram.

4- Conclusion

ZnTe: mn thin films were successfully obtained by pulsed laser technology. Optical and structural properties of ZnTe: mn thin films. The films are closely related to the composition, as the films showed a cubic structure of the mixed phase of zinc telluride with manganese. The thin films showed peaks associated with the increase of Te. Size and lattice parameters were adjusted using Mn as denatured. The permeability showed a decrease in the deformed films. It was found that the energy gap of pure and doped thin films is (2-2.23 eV), respectively. The XRD results showed that the films are polycrystalline deposits and the quality of the thin films can be significantly improved by using Mn. The widening of the peaks is observed due to the coarseness of the grain size. With the properties mentioned, we can find potential applications in electronic devices, such as solar cells and photodetectors.

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